# PATENT SPECIFICATION

769,258

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International Classification:—B29d, B62g.

COMPLETE SPECIFICATION

## Improvements in or relating to Tire Construction

We, THE B. F. GOODRICH COMPANY, a Corporation organised under the Laws of the State of New York, United States of America, of 230 Park Avenue, New York, State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the tread portions of vehicle wheel tires.

It has been found that vehicle tires of the size and type employed on trucks, tractors, farm equipment, and the like, are frequently subject to damage in the tread portion due to the formation and/or growth of cracks. These openings permit the intrusion of dirt, moisture and other foreign matter which rapidly deteriorate the tire causing it to fail, or at least to become unsafe for use, long before the tread elements have been worn to the extent requiring replacing. This type of tire failure is not only expensive by virtue of loss of the mileage remaining in the original tread, but also because such defects generally render a tire unsuitable for recapping or retreading operations.

Cracking or checking in the tread grooves of a tire may be due to a number of causes such as: excessive flexing resulting from insufficient inflation; mechanical damage such as cuts by glass, stones or the like; "growth" of the tire as the result of stretch of the cords employed therein; or chemical changes in the rubber resulting from exposure to ozone, ultraviolet light, certain chemicals, or the like. While the problem of formation and growth of cracks in vehicle tires is frequently encountered in tires having relatively wide grooves such as utilized on trucks or tractors, and is especially pronounced in tires employing nylon cords in the carcass, the problem is not restricted to such tires but may occur in tires of other types and employing cords of other material.

An object of this invention is to provide an improved vehicle tire construction wherein formation of cracks in the tread area, especially in the tread grooves, is substantially eliminated and the growth of cuts or cracks in that area is materially reduced.

Another object of the invention is to provide an improved vehicle tire wherein the tread portion, and especially the bases of the grooves therein, are provided with a layer of an iso-olefin-polyolefin interpolymer, thereby substantially eliminating crack formation due to tire growth, flexing, exposure to ozone, and the like.

A more specific object of the invention is to provide an improved vehicle tire having a carcass of rubber and cords, at least some of which cords are nylon, and a tread of spaced tread elements with intervening grooves wherein at least the bottoms of the grooves have a surface formed by a layer of an iso-olefin-polyolefin interpolymer rubber.

An additional object of the invention is to provide an improved tire as defined in any of the preceding paragraphs, and wherein the rubber beneath said surface layer is natural rubber, a butadiene-styrene compound, or combinations thereof.

A further object of the invention is to provide an improved composite strip of rubber compound for forming the tread and sidewall coverings of a vehicle tire, which strip comprises a surface layer of an iso-olefin-polyolefin interpolymer in the central tread portion superimposed upon and adhered to a base portion of another and different rubber compound.

An additional object of the invention is to provide an improved composite strip of rubber compound as defined in the preceding paragraph, wherein the said surface layer is adhered to the base by one or more layers of rubber tie gum.

Other, and further objects and advantages

of the invention will be apparent to those skilled in the art to which it pertains from the following description of the present preferred embodiment, and certain modifications thereof, described with reference to the accompanying drawings, in which:

Fig. 1 is a fragmentary transverse sectional view through a vehicle tire embodying this invention;

Fig. 2 is a transverse sectional view through a portion of a tire building drum showing a tire carcass and a portion of the tread stock thereon at one stage in the construction of a vehicle tire built in accordance with one procedure and embodying the invention, the view being to a smaller scale than Fig. 1;

Fig. 3 is an enlarged fragmentary transverse sectional view through a tire building drum showing, to an enlarged scale, a portion of the tire carcass and tread stock provided thereon during an operation subsequent to that illustrated in Fig. 2;

Fig. 4 is a view similar to Fig. 3 showing the final tread stock forming step in the tire building operation illustrated in Figs. 2 and 3;

Fig. 5 is an enlarged fragmentary perspective view with parts broken away showing the manner in which a tread splice is formed in accordance with another mode of constructing a tire embodying the invention; and

Fig. 6 is a transverse sectional view similar to Fig. 2 showing a modified form of tread and sidewall strip for a vehicle tire embodying the invention.

A vehicle tire 10 comprises the usual carcass 11, formed by plies of rubber coated cords, covered by rubber sidewalls 12 and tread portion 13, see Fig. 1. Such a tire may be constructed by building the several component parts thereof upon a drum, a portion of which is indicated at 14 in Fig. 2. Thus, the usual plies 15 of rubber coated cords are assembled on this drum, the beads 16 are incorporated therein, and then a layer of rubber tread stock 17 is placed thereover, which stock comprises the material for the sidewalls 12 as well as the tread portion 13 of the tire. After assembly in this manner, the tire is removed from the drum 14, formed into the usual shape and cured by heating to an elevated temperature while confined in a mold. During the curing operation the tread pattern, comprising the tread elements 18 with intervening grooves 19, are formed by the mold surfaces as will be readily understood by those skilled in the art.

Tires constructed in this manner and employing conventional materials frequently develop cracks in the bases of the grooves 19 and this defect is especially prevalent in tires of larger sizes such as those employed for trucks, tractors, farm equipment, and the like. Moreover, small cuts or abrasions caused by stones, glass or the like, entering the tread grooves, frequently grow to form cracks of objectionable sizes. Such crack formation and growth in the grooves of the tire tread are especially pronounced in tires having nylon cords in the carcass and also in tires of that and other cord content when the tires are exposed to an atmosphere containing more than average percentage of ozone.

The presence of nylon cords in the tire tends to cause "growth" of the tire, that is, increase in its dimensions during use, with the result that high lateral stresses are developed in the tread groove areas, thereby facilitating the formation and/or growth of cracks in this region. The effect of ozone in causing checking and cracking of rubber products is, of course, well known. Checking or cracking in the sidewalls of tires exposed to such an atmosphere may affect the appearance but is generally not particularly functionally troublesome. Cracks of this nature developed in the tread grooves, however, frequently grow into deep crevices extending to the carcass into which moisture and other deleterious substances enter, causing premature failure of the tire.

Cracking of tires in the tread grooves and growth of cuts therein are substantially reduced, if not completely eliminated, by providing layer of a rubbery iso-olefin-poly-olefin interpolymer, commonly known as "Butyl" rubber, over the tread portion of the tire, and especially in the surfaces of the grooves 19 of the tire tread at or adjacent the bottoms of those grooves. One procedure by which this layer may be provided is by laminating a quantity of "Butyl" type rubber upon the usual tread stock 17 during the tire building operation. Thus, as indicated in Fig. 2 of the drawings, the tire is formed upon the building drum in the conventional manner by placing thereon the usual plies 15 of rubber-coated cord and incorporating therein the tire beads 16. This carcass is then covered by an elongated strip of rubber tread stock 17, which has a central thickened portion 20, from which the tread elements 18 are ultimately formed, and integral side or laterally extending portions 21 that provide a cover for the sidewalls of the completed tire. The tread stock 17 may be formed of any of the rubber compounds now commonly employed in tire manufacture including natural rubber, synthetic rubber of the butadiene-styrene type, combinations of the latter with natural rubber, and/or other like materials as are now well known. The central portion 20 of this tread stock is, however, preferably made thinner than in conventional practice, this reduction in thickness being substantially equal to thickness of the layer or layers of rubber material added, in accordance with this invention, to provide

the aforementioned crack resistant surface for the tread elements and grooves.

After the ends of the tread stock strip 17 have been spliced together upon the building drum 14, the upper surface of the central portion 20 of the stock is wiped with a thin rubber tread cement or solvent. Over this is placed a layer or layers of rubber tie gum material substantially equal in width to that of the tread portion 20 of the stock 17. This layer of tie gum is spliced at a location circumferentially spaced from the splice of the tread stock 17, and over the tie gum is placed the layer of rubbery iso-olefin-polyolefin interpolymer, which is indicated at 22 in the drawings. A tire thus constructed is then removed from the building drum and cured in the usual tire curing mold, thus producing the tread elements 18 and grooves 19 which are surfaced or covered by the layer 22 of the interpolymer.

Fig. 1 of the drawings shows the layer 22 of the iso-olefin-polyolefin interpolymer as being of substantially uniform thickness throughout all portions of the cured tread area. This is not essential since the need for the layer is less in some areas than it is in others. Thus, the upper sidewalls of the grooves 19 are seldom subject to cracking or checking, and such cracking or checking as occurs in these locations is generally not of serious nature. However, at and adjacent the bottoms of the grooves 19 in the tread cracking and cut or crack growth have been a serious problem and hence the need for the layer is greatest in that region.

The layer 22 of iso-olefin-polyolefin interpolymer resists cracking, checking and deteriorations of the tread area which are produced by ozone, ultraviolet light, and other deleterious substances, as well as resisting growth of cuts or breaks produced by other causes. Hence, the entire tread area is protected against deterioration during storage of the tire while new. When the tire is placed in use, the layer 22 of the interpolymer on the surfaces of the tread elements is, of course, soon worn off, but this is of no consequence since continued protection of these surfaces is not necessary. The layer 22 of interpolymer at and adjacent the bottoms of the grooves 19, however, remains as long as any tread is present upon the tire and affords protection against cracking in the tread grooves until such time as the tire must be recapped or removed from service.

In the presently preferred embodiment of the invention, the tie gum between the tread stock 17 and the interpolymer layer 22 is laminated from two different gum compositions including different amounts of bromine-containing iso-olefin-polyolefin interpolymer. The inner of these layers, namely, the layer 23, adjacent to the tread base stock 17, contains the lesser amount of the bromine-containing interpolymer whereas the outer or second layer 24 contains a greater amount of the brominated interpolymer. These layers of tie gum are each preferably in the order of 0.015" in thickness and may be laminated together upon a suitable calender or the like. When supplied in this manner to the tire builder, the tire tread base stock 17 is, as mentioned before, provided with a thin rubber cement or solvent in the tread portion 20, after which a length of the laminated tie gum stock 23, 24 is placed over the cemented central portion of the stock 17, see Fig. 3. The location of the splice joining the two ends of the strip of laminated tie gum stock is preferably spaced circumferentially from the splice joining the ends of the tread stock 17.

After the tie gum has thus been applied, the layer 22 of the iso-olefin-polyolefin interpolymer, which may have a thickness in the order of 0.070", is applied over the tie gum with the width of this layer 22 being substantially the same as the width of the tie gum layers 23, 24. The ends of the strip of this surface layer 22 are spliced together at a point circumferentially spaced from each of the splices for the stock 17 and the tie gum layers 23, 24. The assembled tire is then removed from the drum 14 and cured, as herebefore described, whereupon the interpolymer layer 22 will be integrally united or bonded with the tread stock base and the latter with the carcass portion of the tire to form one unitary whole, the interpolymer layer surfacing or covering the tread elements and grooves.

The composition of the tie gum layer 23 is such that it is compatible with the rubber of the tread stock 17, the layer 24 is formed of a composition compatible with the interpolymer surface layer 22, and the layers 23 and 24 are mutually compatible. It will be apparent that these several layers may be formed from a variety of compositions. However, by way of example, the following compositions may be mentioned as suitable for satisfactory tire construction embodying the principles of this invention:

| | *Parts by Weight* | |
|---|---|---|
| *Material* | *Layer 23* | *Layer 24* |
| Bromine-containing iso-olefin-polyolefin interpolymer | 45.00 | 100.00 |
| Natural rubber | 55.00 | — |
| Zinc oxide | 5.00 | 3.00 |
| Stearic acid | — | 1.50 |
| Carbon black | 35.00 | 30.00 |
| Sulfur | 2.00 | 2.00 |
| Accelerators | 1.00 | 1.10 |
| Softener | — | 10.00 |
| | 143.00 | 147.60 |

The iso-olefin-polyolefin interpolymer comprising the surface layer 22 preferably

includes a major proportion of isobutylene and a minor proportion of isoprene together with various other ingredients normally employed in rubber compounding, the following composition being an example of one suitable compound:

| *Material* | *Parts by Weight* |
|---|---|
| Iso-olefin-polyolefin interpolymer (about 97% isobutylene, 3% isoprene) | 100.00 |
| Carbon black | 50.00 |
| Stearic acid | .50 |
| Polydinitroso benzene | .50 |
| Zinc oxide | 5.00 |
| Accelerators | 2.00 |
| Sulfur | 2.00 |
| Softener | 3.00 |
| | 163.00 |

While the tie gum layers 23 and 24 have been described as laminated together prior to the tire building operation, it will be apparent that these layers could be separately supplied and incorporated by the tire builder as sequential steps. It will also be apparent that the surface layer 22 of the iso-olefin-polyolefin interpolymer could be laminated with the two plies of tie gum 23 and 24 to form one lamination three plies thick, which could then be supplied to the tire builder and applied by him to the tread stock 17 as a single operation.

As a still different mode of operation, the tread stock 17 could be formed as above described with the crown or central tread portion 20 of lesser thickness than conventional, and the tie gum layer or layers and the surface layer 22 of the interpolymer laminated upon this stock 17 thus providing one complete laminated tread stock which could be applied to the tire carcass as a unit by the tire builder. When a laminated tread stock of this type is utilized, it is preferable that the transversely extending edge of the splice be provided with a strip 25 of tie gum having a composition corresponding preferably with that in the second layer 24, see Fig. 5. The width of this strip should be such that it at least completely covers the edge of the layer 22 so that any overlapping of the inner or base rubber stock 17 with the layer 22 in the splice area, will be protected from direct contact therebetween thus insuring proper bonding in the splice area during the curing operation.

In a still different embodiment of the invention, the interpolymer surface layer may be formed from a bromine-containing iso-olefin-polyolefin interpolymer, which is itself compatible with the rubber stocks commonly employed in tire tread construction, such as natural rubber and butadiene-styrene compounds containing natural rubber and other materials. When such a surface or layer of material is to be employed, it will, of course, be evident that the interposed tie gum layers such as 23 and 24 are not necessary. Consequently, the tread stock 17 can, as shown in Fig. 6, be directly laminated with a surface layer 22' of such bromine-containing iso-olefin-polyolefin interpolymer and this laminated strip supplied as a unit, to the tire builder, who will then apply it to the tire carcass in the manner which will now be readily apparent. A tire constructed in this manner is cured by the conventional procedure thereby causing integral bonding of the surface layer 22' with the tread stock 17 to provide protection against crack formation and growth in the tread of the tire, especially in the tread grooves thereof, as has been before described.

The phenomenal improvement in resistance to crack formation and growth in vehicle tires provided with the above described surface layer of iso-olefin-polyolefin interpolymer is shown by comparison of tires constructed with conventional tread stocks of natural rubber, butadiene-styrene, or combinations thereof with those having tread stocks of like material but provided with a veneer or layer of the interpolymer as has been herein described. Thus, tires which were formed with a surface veneer or layer as described in the preferred embodiment were found to have a satisfactory rate of wear, and at the end of tire test mileage in the order of 20,000 miles, exhibited no tread cracks. In contrast thereto, tires used as a test control and formed of the same material and by the same modes of construction, but without the surface layer, were found at the end of like mileage operation to have developed independent tread cracks in the order of from 100 per tire to continuous cracking throughout the entire tread groove area. Tires constructed in accordance with this invention were also found to exhibit greatly improved resistance to crack or cut growth; that is, resistance to increase in dimension of cracks artificially produced, as, for example, by cutting or slitting in the tread groove region. Thus; with tires constructed in accordance with the preferred embodiment of the invention, crack growth from initial cuts in the tread groove area were only two-thirds as great as that in control tires constructed in the same manner as the improved tires but without the afore-mentioned layer or surface of interpolymer in the tread groove region.

The invention may be employed with tires other than those normally utilized for trucks, tractors, farm equipment or the like, and will exhibit like improvement in resistance to crack formation and growth. Moreover, the invention may be utilized with tires other than those in which the cords are, in part, or entirely formed of nylon cord. Also, it will be evident that the invention may be in-

corporated into tires by methods of tire manufacture other than those specifically described and that the thickness and compositions of the component materials may be varied so long as the construction results in the provision of an appreciable layer of an iso-olefin-polyolefin interpolymer in the tread groove areas. In this latter regard it should be noted that the layer 22 or 22' need not have the rubber constituent as 100% iso-olefin-polyolefin interpolymer but may comprise mixtures thereof with other elastomers. Moreover, although the tie gum layer 23, 24 and the layer 22', utilized without tie gum, have been described as including bromine-containing iso-olefin-polyolefin interpolymers, it will be apparent that other halogen-containing interpolymers may be utilized. The surface layer 22 or 22' may, for example, comprise up to 40% natural or equivalent elastomer with the remainder being a halogen-containing iso-olefin-polyolefin interpolymer.

What we claim is:—

1. A tire tread having spaced tread elements with intervening grooves wherein at least the bottoms of the grooves are surfaced by a layer containing at least 60% of a rubbery iso-olefin-polyolefin interpolymer adhered to and covering a base of a different rubber composition.

2. A tire tread according to Claim 1, in which a halogen-containing iso-olefin-polyolefin interpolymer is used.

3. A tire tread according to Claim 2, in which the interpolymer is of the bromine-containing type.

4. A tire tread according to any one of the preceding claims, in which said different rubber compound is of the butadiene-styrene type.

5. A tire comprising a tread as claimed in any one of Claims 1-4.

6. A tire according to Claim 5, comprising a carcass of rubber and cords with said tread portion surrounding the carcass and united therewith, at least some of said cords being nylon.

7. A composite strip for forming the tread and sidewall covering of a vehicle tire according to Claim 5 or 6, the said strip comprising a central laminated portion with a surface layer of an iso-olefin-polyolefin interpolymer rubber compound overlaying a base of a second and different rubber compound, said base having marginal portions extending beyond each side edge of said surface layer for forming the sidewall covering of a tire, whereby application of the composite strip to a tire carcass and vulcanization thereof in a tire mould having a tread pattern results in integral union of said surface layer with said base with the said surface layer constituting the outer surface of the tread elements and grooves in the tread pattern.

8. A composite strip according to Claim 7, in which said surface layer is united with said base by interposed gum rubber compound having a composition compatible with the rubber compounds of said surface layer and base.

9. A composite strip according to Claim 8, in which said gum rubber compound includes a halogen-containing iso-olefin-polyolefin interpolymer and said base is a butadiene-styrene compound.

10. A composite strip according to Claim 7, in which the said surface layer is united with said base by two interposed layers of tie gum rubber compound, the first of said layers of tie gum being in contact with said base and having a composition compatible with the rubber compound of said base, the second of said tie gum layers being in contact with the first tie gum layer and said surface layer and having a composition compatible with the said surface layer, the said tie gum layer compositions being mutually compatible.

11. A composite strip according to Claim 10, in which said base is a butadiene-styrene compound and said tie gums each include a bromine-containing iso-olefin-polyolefin interpolymer with the first of said tie gum layers containing a lesser amount of said bromine-containing interpolymer than the second of said tie gum layers.

12. A tire tread substantially as hereinbefore described with reference to Fig. 1 of the accompanying drawings.

13. A composite strip for forming the tread and sidewall covering of a vehicle tire substantially as hereinbefore described with reference to Figs. 2-6 of the accompanying drawings.

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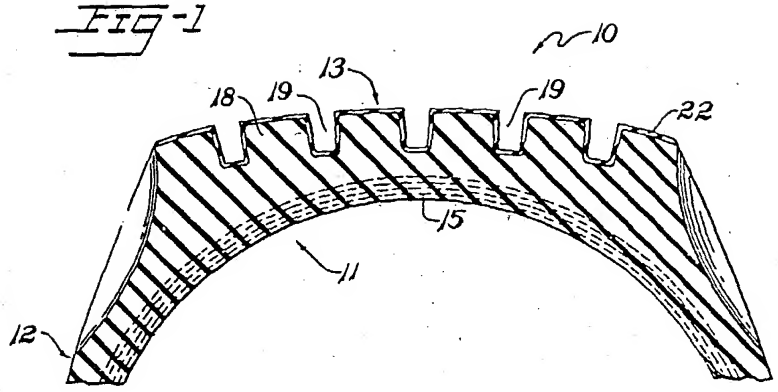
Fig-1



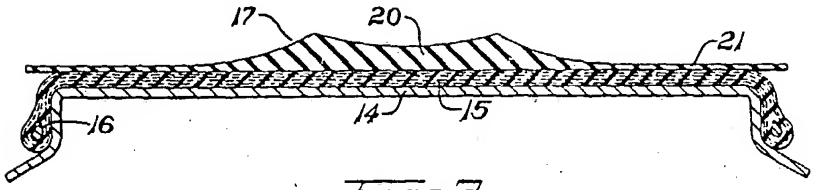




Fig-2

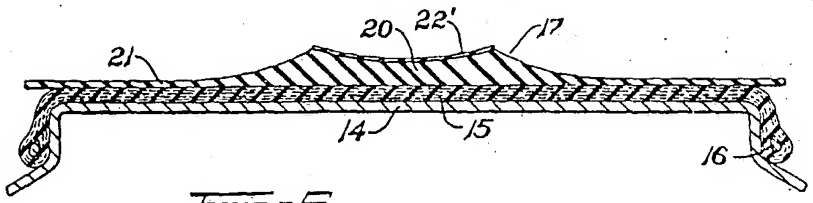



Fig-6

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Fig-3

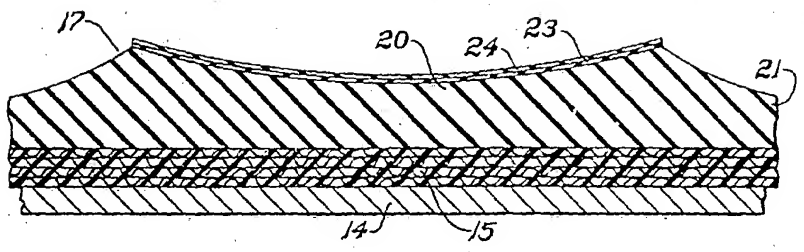


Fig-4

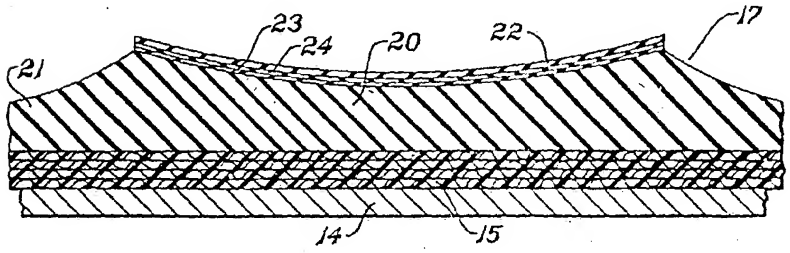


Fig-5

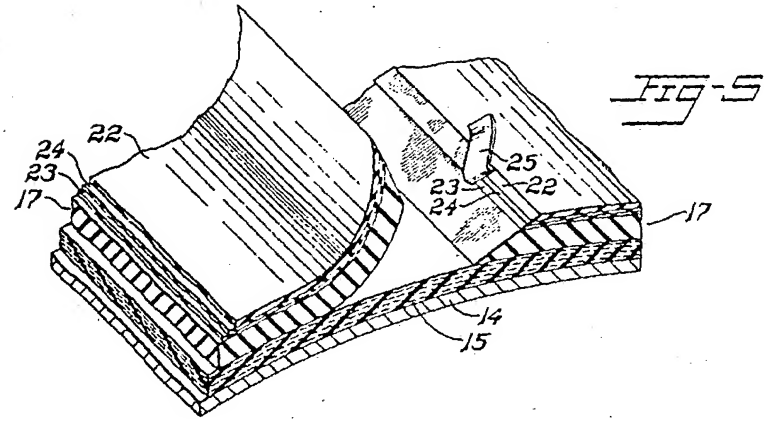

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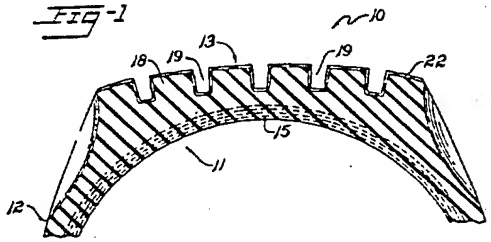
Fig-1



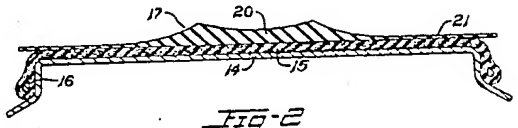




Fig-2

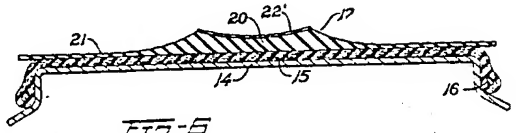



Fig-6

Fig-3

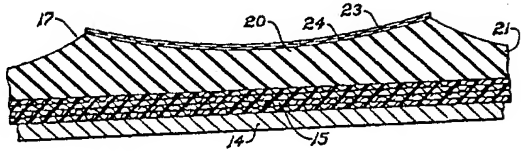



Fig-4

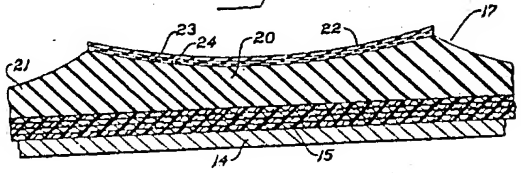



Fig-5